

Lab-scale study of the calcium carbonate dissolution and deposition by marine cyanobacterium *Phormidium subcapitatum*.

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**Background** Suggestions that calcification in marine organisms changes in response to global variations in seawater chemistry continue to be advanced (Wilkinson, 1979; Degens *et al.* 1985; Kazmierczak *et al.* 1986; R. Riding 1992). However, the effect of  $[\text{Na}^+]$  on calcification in marine cyanobacteria has not been discussed in detail although  $[\text{Na}^+]$  fluctuations reflect both temperature and sea-level fluctuations. The goal of these lab-scale studies therefore was to study the effect of environmental pH and  $[\text{Na}^+]$  on  $\text{CaCO}_3$  deposition and dissolution by marine cyanobacterium *Phormidium subcapitatum*.

**Methods** Marine cyanobacterium *P. subcapitatum* has been cultivated in ASN-III medium.  $[\text{Ca}^{2+}]$  fluctuations were monitored with  $\text{Ca}^{2+}$  probe.  $\text{Na}^+$  concentrations were determined by the initial solution chemistry.

**Results** It was found that the balance between  $\text{CaCO}_3$  dissolution and precipitation induced by *P. subcapitatum* grown in neutral ASN III medium is very close to zero. No  $\text{CaCO}_3$  precipitation induced by cyanobacterial growth occurred. Growth of *P. subcapitatum* in alkaline ASN III medium, however, was accompanied by significant oscillations in free  $\text{Ca}^{2+}$  concentration within a  $\text{Na}^+$  concentration range of 50 – 400 mM. Calcium carbonate precipitation occurred during the log phase of *P. subcapitatum* growth while carbonate dissolution was typical for the stationary phase of *P. subcapitatum* growth. The highest  $\text{CaCO}_3$  deposition was observed in the range of  $\text{Na}^+$  concentrations between 200 – 400 mM.

Alkaline pH also induced the clamping of *P. subcapitatum* filaments, which appeared to have a strong affinity to envelop particles of chemically deposited  $\text{CaCO}_3$  followed by enlargement of those particles' size. EDS analysis revealed the presence of Mg-rich carbonate (or magnesium calcite) in the solution containing 10 – 100 mM  $\text{Na}^+$ ; calcite in the solution containing 200 mM  $\text{Na}^+$ ; and aragonite in the solution containing with 400 mM  $\text{Na}^+$ . Typical present-day seawater contains xxmM  $\text{Na}^+$ . Early (Archean) seawater was likely less saline.

**Conclusion** The division of marine cyanobacterium *P. subcapitatum* is associated with periodic deposition and dissolution of  $\text{CaCO}_3$ , the rhythms and intensity of which are dependent on concentrations of both  $\text{OH}^-$  and  $\text{Na}^+$ . Thus, the role of present-day marine cyanobacteria in the global carbonate cycle might be reduced to aggregation and re-crystallization of available  $\text{CaCO}_3$  particles in marine water rather than long-term precipitation and accumulation of  $\text{CaCO}_3$  deposits. For lower  $\text{Na}^+$  concentrations, precipitation of carbonates by cyanobacteria would be even less significant. These results suggest that the lack of calcified cyanobacteria in stromatalite-bearing Precambrian sequences can be explained not only by high dissolved inorganic carbon concentrations but also by lower salinity, as well as possible lower pH compared to present-day oceans.

1. Karakis SG, Dragoeva EG, Lavrenyuk TI, Rogochiy AB , Gerasimenko LM, McKay DS, and Brown II. The Joint International symposium for Subsurface Microbiology and Environmental Biogeochemistry. Jackson Hole, WY, August 14-19, 2005. P.115